

## Comparative Analysis of Water Quality in Hand Dug Well and Borehole in Calabar South Local Government Area in Nigeria

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### ABSTRACT

The shortage of water supply in Calabar South by the State Water Company has forced private individuals to drill boreholes and hand dug wells for private and commercial purposes. Some individuals, whose financial status is low, take the objection of digging a hand dug well which serves as a source of water supply to them, hence the need to ascertain the wholesomeness status of this source of water supply. Two boreholes and two hand dug well were selected from the study areas for the study. Two boreholes and two hand dug wells were randomly selected from the study area for the purpose of the study. Two samples were taken from boreholes at different street within the study area and vis-visa. The samples were analyzed based on the standard method of analysis. The result shows that the total coliform count of the boreholes samples met the WHO recommended standard, while the total coliform of hand dug well did not meet the WHO standard. Turbidity, Nitrate all met the WHO standard for both boreholes and hand dug wells. The result shows that the borehole samples contain zero coliform count as compared to the hand dug wells with numerous bacterio-logical count of 50 to 60 and 2 numbers of total coliform count (TCC) each respectively. Only the borehole samples met the World Health Organization (WHO) standard as shown in Table 2. Turbidity, nitrate, DO, BODs, COD, TDS all met the WHO standard, except the pH value which gives values ranging from 4.95 to 5.30 indicating acidity and require treatment with lime to raise the pH value to values close to 7.

**KEYWORDS:** Boreholes, dug wells, water samples, source of water and coliform bacteria.

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### I. INTRODUCTION

Water is a very essential substance for human existence. Adequate supply of water is important to life and civilization. Water has come to be the factor to all the basic needs to man.

The provision of water in the past was solely governmental affairs but the inability of the government to meet to the daily demands of water for the people has made some private individuals and some villages to find other alternatives of providing water. Private individuals drill their own deep wells (boreholes). In some locality as in villages, they dig wells. If they cannot afford boreholes. They dig hand dug well to supply water for the villagers. Water meant for food preparation and drinking must be free from contamination (organism) capable of causing diseases and from minerals and organic substances producing adverse physiological effects. Water from deep wells is been sold to the public without reference to the approved standard from World Health Organization (WHO).

Water in its natural state has never been pure, rain water contains dissolved oxygen (DO), nitrogen and carbon dioxide from the atmosphere. Surface water is exposed to human and animal activities and is easily contaminated and polluted.

Government and researchers has made it their duty to assess the quality of water supply to the society. These study therefore focuses on an experimental programs designed to identify factors that affect the water quality in Calabar South for domestic uses.

## **1.2 Research Problem**

Human activities on the environment often at times result to pollution and degradation which are directly detrimental to human beings. If the situation is not properly handled it could result in serious environmental hazard.

The source of water supply must be potable and wholesome or else people may decide to turn down the general supply of water and supply water for themselves from other sources which are appealing but may not be safe for consumption.

## **1.3 Research Objectives**

The increase in rate of degradation of our environment in agriculture and industrial activities, there has been cases of outbreak of diseases in various parts of the communities. The following therefore are the main objectives of this study:

1. To determine the physical, biological and chemical characteristics of the available source of water within the proposed area of study.
2. To access the quality of water obtained within the proposed study area.
3. To recommend to government and the private individuals ways of improving the present situation.

## **1.4 The Study Area**

Nelson Mandela, Palm Street, Edem Edet and Afokang communities constituted the study area and is situated in Calabar, the capital of Cross River State. Calabar lies on latitude  $4^{\circ}50'$  and  $3^{\circ}05'$  South and longitude  $8^{\circ}25'$  East with annual rainfall average 1,839 millimeter.

The region has a raining season from April until October, during which 80% of the annual rainfalls with peak in June and September.

The location of the University within these communities impacts positively on the population of these areas. Calabar South has the total population of 191,515 at the year 2006. The habitants of these areas are mainly students, civil servants and traders etc.

Water is one of the abundantly available substances in nature and form 70% of the earth's crust. It is regarded as a very vital necessity of life and is a part of every living cells. Water is vital for living processes, animals and plants need it for survival. Villages and towns can only be constructed if there is enough water for their use.

Apart from cooking and drinking, water is used for cleansing. Drinking water must be pure not polluted. Water is such a widespread material that its presence is accepted without question and its importance is really appreciated when there is a shortage.

Water like air is one of the most indispensable substances in life and it is only when we are deprived of the substances that we can truly appreciate their value (Dada, 1996). Aliero (2005) noted that "water is life, if governance is primarily about protecting lives and properties of the citizens, then the provision of portable and quality water should be the basic thing to any determines government.

The federal government policy on water supply guarantees the provision of water as one of the primary needs to man, which any good government is obliges to perform to its citizens. It is the aim of the government during this plan period to make portable water available to increasing population of people at reasonable rates and to meet the consuming rate per people per day which is 113.6 litres in all major urban centres and to ensure that all communities of about 20,000 people or more are supplied with pipe borne water during this planned periods (1970-1974). Second national development plan (1970-1974 Vol. 1).

According to WHO (1984) water is used for the following purpose:

1. Domestic and municipal supply, industrial water supply, food and beverage industries, Boiler and water pharmaceutical and antibiotic requirement, internal combustion engines, transportation and process, aquatic life and recreation, agricultural water supply.
2. The availability of water has become a critical and urgent problem in many developing countries. This is a matter of special concern to families and communities depending on one – source of public supply system (EDEMA and Others, 2001)
3. The pH of the water should be stabilized by treating water with lime in order to raised it pH value since low pH value will have significant effect on man's health, causing various sickness.

It was noted by Agunwanba (2001) that the sources of pollutants are: Sewage, urban runoff which depends on the sanitary condition of the catchments in the atmosphere, agriculture affluent consisting of chemical fertilizer, herbicides and pesticides, industrial sources which are related to different types of chemical, pollutants, organic and inorganic matters, microbial organisms and toxic chemicals.

For water to be pure and wholesome for supply, it must be free from the following impurities: colour, taste and odour, objectionable dissolved matter, bacterial indicative of pollution, visible suspended water and aggressive constituents (Tebbutt, 1973). Not that the quality of water is governed by various physical, chemical and microbial interaction (Edema and Others, 2001). Chemically, water do contain metallic chlorides, bicarbonates of calcium, magnesium, iron, silicates compounds, sulphate and clay particles and carbonic acids as dissolved gases in varying levels and degrees. These pollutants at a high level may collectively or singly make water unsafe for drinking.

These pollutants causes odour, obstruction of light and oxygen for growth, respiration of fish and other aquatic animals, impair recreational and above all domestic uses. Nwosu and Ogueke (2004) noted that water quality deterioration resulting from pollution is vital to those responsible for the application of water for various uses.

Some of the water pollution should be known. The pollution of water is clearly undesirable for many reasons and are:

- (i) Creation of nuisance by appearance and odour following gross pollution.
- (ii) Effect on fish: fish required high dissolved oxygen (DO) level and partially not found if the (DO) is greater than 5mg/l.
- (iii) Contamination of water supply resulting in an additional load on water treatment plants, increasing the cost of treatment and often causing taste and odour problem.
- (iv) Restriction of recreational use: bathing and swimming are unsafe in polluted waters (Tabbutt, 1973).

Some communicable diseases are related to contaminated untreated supplies. These disease result in mobility temporary disability, lost of productivity and leisure time, strain on health services and social economic losses (Agunwanba, 2000).

According to the national water resources policy (2003), water related diseases are the major causes of mortality and mobility, with malaria, schistosomiasis, diarrhea, onuchocercias all projecting serious threats to public health.

The outbreak of water borne diseases and epidemics nationwide arising from drinking water of unsafe quality have become a great concern (FEPA, 1991).

The quality of water in Owerri metropolis according to investigation by researchers such as Nwosu and Ogueke (2004); shows that the physical analysis, four out of the fifteen samples did not meet the world health standard for taste while other characteristics met the recommended standards for appearance colour, odour, turbidity and total dissolved solids. The chemical analysis met the recommended standards for residual chlorine, pH, total hardness, lead, nitrate, iron, magnesium, copper, mercury, sulphate and calcium set by WHO (1984). Biologically, the total plate count was above the recommended value of 100Cfu/ml by WHO which is adopted by NAFDAC in Nigeria. Some samples gave positive coliforms while others were positive for E-coli.

## **II. MATERIALS AND METHODS**

The research design for this study is experimental in nature. It involves scientific collection of water samples from the borehole and hand dug well water supply sources in the study area. The analytical design involves the examination of physicochemical and bacteriological parameters of the water samples. The results of the analyses were compared with the World Health Organization (WHO, 2006) standards for drinking water.

The main materials used for this study were water samples collected from different sources and places, and the usual apparatus in a sanitary engineering laboratory in accordance with ALPHA (1998).

## 2.1 Collection of Water Samples

Water samples were collected using clean containers, labeled and transported immediately to the laboratory in a container of ice for physicochemical analysis. For bacteriological analysis, five drops of aqueous sodium thiosulphate solution were added to the sample bottles and sterilized in a hot box oven at 160°C for one hour. The addition of the solution was to neutralize any available chlorine in the samples. The samples were labeled and transported to the laboratory in a cooler (container) of ice. Table 1 shows randomly selected sample locations, sources and sample identification code.

**Table 1:** Randomly selected sample locations, sources and sample identification code

Sample Location	Source of Supply	Sample Identification Code
Nelson Mandela	Borehole 1	B1
Palm Street	Borehole 2	B2
Edem Edet	Hand Dug Well 1	W1
Afokang	Hand Dug Well 2	W2

## 2.2 Methods of Data Collection and Presentation

Water samples were collected from boreholes and hand dug wells for physicochemical and bacteriological analysis using standard analytical techniques and instruments such as portable pH meter (HACH Sension 3) to measure pH, an automatic absorption spectrometer (UNICAM 969 AA) to measure the concentration of trace metals and dissolved oxygen meter (JYD – IA) to measure the dissolved oxygen. Other physicochemical parameters like temperature, turbidity, electrical conductivity, total dissolved solids, alkalinity, biochemical oxygen demand, chemical oxygen demand were determined using the appropriate instruments, (ALHA, 1998). The biological parameters such as total coliform count (TCC) and (THC).

## III. RESULT

The World Health Organization WHO (2006) standard was used as the criteria in comparing the water standard from each location under investigation. The results obtained are presented in Table 2 below.

(i) **Temperature:** Table 2 shows the result of the temperature of water samples from difference location temperature value of 25°C was recorded at location B1, while 24°C was recorded at the location B2 and hand dug wells (w1 & w2) recorded 25°C each. There was significant variation in the temperature. On the average the borehole samples and sample from hand dug wells met the recommended standard.

(ii) **Total Coliform:** The results of the total coliform test are represented in Table 1 and 2. Values of coliforms/100ml of samples were recorded from boreholes B1, B2, the numbers recorded from boreholes B1, B2, met the WHO (2005) permissible limit.

The WHO limit of TCC is 1 per 100ml these means that the water was not polluted and there was no presence of micro-organism in the water in the study area. While in hand dug wells (w1 and w2) it was found that the water was polluted and it exist the WHO standard of 1 per 100ml, which w1 and w2 recorded 2 per 100ml respectively.

Micro-organism presence in the water in the study areas points to the fact that the water has been polluted. The level of coliforms in the hand dug wells may be due to discharges from refuse dumping around the wells and the soak away.

The result shows that boreholes location such as B1 and B2 did not have any total coliform count. The WHO acceptable limits were met and the water was considered portable for drinking. But that of hand dug wells rises more than the WHO standard and as such considered not suitable for drinking.

(iii) **Determination of pH:** Table 1 and 2 shows the result for the potential hydrogen ions concentration of the samples. Boreholes B1 value was 5.30 while that for borehole B2 was 5.29. Therefore, the average for hand dug wells w1 and w2 values where 4.97 and 4.96 respectively.

None of the samples met the recommended standard of 6.5; they are slightly lower indicating a low content of carbon (iv) oxide in the water. A low pH shows that the solution is acidic and a high pH shows that it is base/Alkaline. pH of 6.8 is the neutral range. Thus both borehole and hand dug well are not suitable for drinking and therefore require treatment using lime.

(iv) **Biochemical Oxygen Demand (BOD<sub>5</sub>):** The BOD<sub>5</sub> are represented in Table 1 and 2. The average values for boreholes B1 and B2 was 0.1mg/l while that of hand dug wells w1 was 0.3mg/l and w2 0.4mg/l. The BOD<sub>5</sub> values do not actually indicate water quality but potential for removing dissolved oxygen from the water and strength of sewage and industrial wastes. A high BOD<sub>5</sub> signifies or indicate the present of a large amount of organic pollution.

(v) **Turbidity:** The results of the turbidity are reflected on Table 1 and 2. The boreholes B1 and B2 have the same turbidity of 0 ETU. However, hand dug wells w1 and w2, the value was also observed to be 0 ETU. This is because; there is less or no activities such as washing and bathing in the water samples. The boreholes and hand dug wells has relatively no values throughout. Therefore, water sample has met WHO standard.

(vi) **Total Dissolved Solid (TDS):** The result of the total dissolved solids are presented in Table 1 and 2, all the samples examined met the WHO recommended standard.

(vii) **Nitrate:** Nitrate was another parameter analyzed. The result is shown in Table 1 and 2. All the sample met the WHO recommended standard. The present of nitrate maybe as a result of waste dump, abattoir around that water source.

(viii) **Dissolved Oxygen (DO):** The result for the dissolved oxygen are shown in Table 1 and 2, the dissolved oxygen was low for boreholes B1 and B2 which is 2.9 and 3.0mg/l respectively and for the hand dug wells w1 and w2 were 3.1 and 3.0mg/l which is lower than the WHO standard of 5 to 14mg/l. The low value of the DO in the boreholes maybe due to the chemical reaction as the water is in contact with the subterranean minerals.

**Table 1:** Comparism of boreholes and hand dug well water quality

Parameters	Unit	Nelson Mandela B1	Palm Street B2	Edem Edet W1	Afokang W2	WHO Standard (2006)	Borehole B1 and B2	Well w1 and w2
pH	-	5.30	5.29	4.97	4.95	6.5 – 8.5	Borehole B1 and B2 have values of 5.30 and 5.29 respectively which are below the WHO standard for drinking water of 6.5 – 8.5. None of the boreholes have met the recommended standard. They are slightly lower indicating a low content of carbon (iv) oxide in the water. A low pH show that it is acidic and a high pH value shows that it is base/alkaline.	The values of well w1 and w2 are 4.97 and 4.95 respectively and as such have not reached the WHO standard of drinking water. The are lower than the figure shown in WHO and is not good for drinking. A low pH shows acidity and high pH shows alkalinity (base) (pH 6.8) is the neutral range.
DO	mg/l	2.9	3.0	3.1	3.0	5 – 14	The dissolved oxygen was low for borehole B1 and B2 is 2.9mg/l and 3.0mg/l respectively. Borehole B1 and B2 did not meet the WHO standard of 5.14mg/l minerals.	For the hand dug wells w1 and w2 which goes with the values of 3.1mg/l and 3.0mg/l each, did not reach the WHO standard of 5 – 14 and as such it is low.
BOD <sub>5</sub>	mg/l	0.1	0.1	0.3	0.4	2 – 4	Borehole B1 and B2 shows the BOD <sub>5</sub> with the average of 0.1mg/l. The BOD <sub>5</sub> values do not actually indicate water quality but potential for removing dissolved oxygen from water. A high BOD <sub>5</sub> indicate the present of biochemical oxygen demand as the BOD <sub>5</sub> was very low.	Hand dug well w1 and w2 has the value of 0.3mg/l and w2 is 0.4mg/l each, and it is less than the recommended WHO standard of 2 – 4mg/l and as such it was low.
Turbidity	ETU	0	0	0	0	5.0	The turbidity value for B1 and B2 are zeros (0) ETU which shows that there is no contamination in water	However, the values for hand dug wells; w1 and w2 were observed to be 0ETU respectively. It indicates that there is

							samples. The borehole has no values that indicate that there is no turbidity in the boreholes and as such is due for consumption. It has met the WHO guidelines.	no activity, which may contaminate the water and has such has meet the WHO standard.
TDS	mg/l	129.4	129.4	326.0	323.0	1000	Total dissolved solid of both borehole B <sub>1</sub> and B <sub>2</sub> has the value of 129.5 and 129.4 respectively. The two boreholes that were observed met the World Health Organization guidelines for drinking water.	The values of both hand dug wells w <sub>1</sub> and w <sub>2</sub> is 326.0 and 323.0 respectively, the samples met the recommended standard by WHO

NO <sub>3</sub>	mg/l	4.982	4.980	5.516	5.519	50	Nitrate was another parameter examined, boreholes B <sub>1</sub> and B <sub>2</sub> was recorded as 4.982 and 4.980 respectively. The presence of nitrate is due to the operation of water source. They met the WHO recommended standard.	The values of nitrate in well w <sub>1</sub> and w <sub>2</sub> were slightly higher than that of borehole. The recorded values for w <sub>1</sub> and w <sub>2</sub> are 5.516 and 5.519 respectively and they met the WHO recommended standard.
TCC	CFU	0	0	2	2	1	Values of total coliform count of borehole B <sub>1</sub> and B <sub>2</sub> samples were recorded as follows 0 and 0 and they were low. The boreholes B <sub>1</sub> and B <sub>2</sub> met the WHO standard which is 1 per 100mg/l. These clearly shows that the water was not polluted and there was no micro-organism in the water in the study area. The water is due for consumptions. These shows that the boreholes B <sub>1</sub> and B <sub>2</sub> do not have any total coliform count. The value for the borehole falls within the WHO standard acceptable limits and as such considered portable for drinking.	Whereas, in hand dug wells w <sub>1</sub> and w <sub>2</sub> examined and recorded the values which are 2 and 2 respectively. It was found to be polluted because it beats the WHO guidelines for drinking water (2006). Therefore, there is the presence of micro-organism in the both wells w <sub>1</sub> and w <sub>2</sub> and that point to the fact that the water is polluted. The level of coliform in the water maybe due to discharge from the dumping of refuse around the wells w <sub>1</sub> and w <sub>2</sub> under the study area rises more than the WHO acceptable limit and as such considered not suitable for drinking.
Temperature	°C	25°	24	25	25	27 - 29	The temperature values recorded for borehole B <sub>1</sub> and B <sub>2</sub> were 25°C and 24°C; there was slightly variation difference in location. But they met the WHO standard of 27 – 29.	Hand dug wells w <sub>1</sub> and w <sub>2</sub> at difference location recorded the same temperature of 25°C and they met the WHO acceptable limit of 27 – 29.

**Table 2:** Analysis of parameters from boreholes and hand dug wells

S/N	Parameter	Unit	Borehole One Nelson Mandela B1	Borehole Two Palm Street B2	Hand Dug Well One (w1) Edem Edet	Hand Dug Well Two (w2) Afokang
1	Physical Temperature	°C	25	24	25	25
2	Physiochemical pH	-	5.30	5.29	4.97	4.95
3	DO	mg//	2.9	3.0	3.1	3.0
4	BOD <sub>5</sub>	mg//	0.1	0.1	0.3	0.4
5	COD	mg//	0.00	0.00	0.20	0.19
6	Turbidity	ETU	0	0	0	0
7	TDS	mg//	129.5	129.4	326.0	323.0
8	NO <sub>3</sub>	mg//	4.982	4.980	5.515	5.519
9	Bacteriological THC	CFU	0	0	60	50
10	TCC	c/100mg	0	0	2	2

### CONCLUSION

The results of the relevant tests such as turbidity, Total Dissolved Solid (TDS), Nitrate and Total Coliform Count (TCC) in Table 2 shows that the Total Coliform Count (TCC) of borehole samples met the WHO recommended standard.

The pH value of all the samples did not meet the recommendation standard by the World Health Organization (WHO) and therefore required further treatment with lime. The Total Coliform Count of the hand dug well did not also meet the recommended standard and therefore requires some treated with lime to increase the pH to the required standard.

The Biochemical Oxygen depend (BOD<sub>5</sub>) of all the samples did not meet the WHO recommended standard. All the borehole samples met the standard for turbidity and all the hand dug wells samples also met the WHO standard. Other examined parameters such as temperature, total dissolve solid and nitrate also met the WHO recommended standard.

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